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REVIEWS AND BOOK NOTICES.

THE EMBRYOLOGY OF FOSSIL CEPHALOPODS.*—This essay contains some of the results of several years' study of the rich collection of fossil Cephalopods contained in the Cambridge museum. The special investigations recorded here were made for the purpose of ascertaining the limits of the embryological period among the typical Ammonites. In order to do this the author made sections of the shell and worked out the form of the embryo or young animal just after being hatched. This may be detected by breaking away the older whorls, and getting at the minute globular sac, which represents the shell in its first stage. This sac may be found in Ammonites and Goniatites, but in the shell of Nautilus it is not retained, though "traces of its former existence are apparent on the apex of the first whorl in the form of a scar or cicatrix. Into this sac opens the first whorl of the shell; other whorls are added, until they form a long series coiled up closely, as in the Ammonites so familiar to geological students." As is well known to palæontologists there are all grades of form from the "straight Orthoceras to the coiled Nautilus, and inversely, among Ammonoids from the closely coiled Goniatites and Ammonites to the straight Baculites; the general morphology being readily and accurately expressed as a coiling up of a straight cone, and the subsequent uncoiling of the same at later stages of the earth's history. The shells are almost universally classified in accordance with this coiling and uncoiling, with which also the structure of the siphon and septa are more or less correlated." Prof. Hyatt has endeavored, and we think with great success, to show that this series of forms is epitomized in the life of the individual Nautilus or Ammonite. The young in these Cephalopods are at first uncoiled like some genera, and the different degrees of coiling up find a permanent expression in the genera of Ammonoids.

He figures the embryos of certain Goniatites, and from the differences presented by them, a succession of forms is detected which accords with what we know of the morphology of these Cephalopods and their geological succession. He concludes that—

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* Fossil Cephalopods of the Museum of Comparative Zoology; Embryology. By Alpheus Hyatt. (Bulletin of the Museum of Comparative Zoölogy, Cambridge, Mass., vol. iii, No. 5. Cambridge, 1872. 8vo. pp. 116, with cuts and four lithographic plates.)

"The range of form has been among the Nautiloids from the straight Orthoceratite through intermediate arcuate genera, to the partially coiled Lituites, and finally the closely coiled Nautilus. Such being the case, if there is any truth in the doctrine of evolution, we must expect to find some reference to the peculiarities of the parent Nautiloid stock in the earlier stages of development among the Ammonoids. And further, as a direct and unavoidable corollary of the above, we ought to find this reference more distinct in the young of the earlier species of Ammonoids, the Goniatites of the Silurian, and less noticeable in Goniatites of the Devonian and Carboniferous, and, finally, almost obliterated, or at any rate, still less distinct in the typical Ammonites of the Jura. So far as the facts have been ascertained, they all point in this direction. The simple Nautiloid-like Goniatites of the Silurian may exhibit an Orthoceratitic or straight form, or be closely coiled in the young of different varieties of two distinct species. A species, therefore, on this horizon, may have a range of variation in form, during the earlier stages of development, equivalent to that occurring among the adult forms of Nautiloids from Orthoceras to Lituites. We find in this a perceptible acceleration in the development of the young precisely proportionate to the estrangement, either in time or in adult organization, of the Ammonoids from their supposed parent stock. There are evidently two tendencies at variance with each other: one strongly reversionary, appearing in the frequency with which the earlier Goniatites repeat the parent form in certain isolated instances in the young of varieties, and in the different species of the later Goniatites manifesting itself in the arcuate cone of the young of *Goniatites compressus* and others of the Nautilini, and in the closer, though non-involute, coiling of the young of other forms. Evidently this tendency is losing its power to affect and modify the organization, or, in other words, its prepotency. The other tendency, which is expressed in the closer coiling of the whorls, and finally in their increasing involution, is decidedly progressive, increasing in power to the final and ultimate extinction of all reference to the ancestral type, except in the internal organization. Here, as will be shown, the siphon for a limited time remains central in the first whorl, and the first septum has a large entire abdominal cell, and simply concave lateral lobes, as in the Nautiloids.

The form, however, of the first whorl of the Ammonoid is like Goniatites, the shell similar, and the second septum has the invariable abdominal lobe, superior lateral cells, and lobes of the simpler adult Goniatites, but not by any means of the simplest Goniatites. The simplest adult Goniatites have no proper lateral cells, but only broad lateral simple curves to the septa, as if the first septum of the Ammonite was modified or broken by a small abrupt lobe on the abdominal side. Contrast this with the development of the septa, and their gradual change in *Goniatites com-*

> *pressus*, and we see at once that the development of the same parts is very much quickened or accelerated in the typical Ammonite.
>
> That this acceleration of development is due to the prepotency of the same progressive tendency as the closer and closer coiling, and final involution of the ovisac, by the first whorl, can hardly be doubted. Thus, not only in the whole series of Nautiloids are the forms more or less completely coiled and finally enveloping, but in the young Ammonoids this process is repeated, but only as a reversionary tendency of individuals and species, or at most, perhaps, by the group of Nautili."

Our author finds that all the typical Ammonites may be resolved into natural series. As bearing upon the question of mimetic forms, we may refer to the observation that the above noticed series "contain more or less representative or mimetic forms due to the resemblance occasioned by the amount of the involution or the characteristics which are usually correlative with the amount of involution." He also indicates the effects upon the individual and the group to which it belongs of the changes due to old age, which have not been sufficiently taken into account by observers.

> "When, however, the organization of the group no longer progresses, but retrogrades by the uncoiling of the whorls in Scaphites, Ancycloceras and Baculites, repeating—as shown by several authors, but notably by Barrande—the earlier forms of the Nautiloids in inverse order, these, though strictly mimetic, are produced by the encroachment of senile characteristics. These are observed in the old age of such species as *Ammonites Humphriesianus*, where the old whorl becomes smaller, more cylindrical and, if growth was continued, must eventually strike off from the regular spiral as in Crioceras or Lituites. This irregularity is found at earlier and earlier stages of growth, and finally affects the whole form as in the completely straightened Baculites. Direct inheritance of senile characteristics is not claimed, but merely that retrogression of the individual in old age and the retrogression of the group are similar, and both due probably to the same cause, exhaustion of the powers of growth."

As an example of Cope's law of "retardation" in accounting for the origin of distinct forms, Prof. Hyatt cites the case of the spiral or Gasteropod genus Turrilites.

> "The young of several species of typical Ammonites often assume the spiral, although this is entirely suppressed at a later stage, and the succeeding whorls resume the normal mode of growth and revolve in the same plane. When, therefore, the normal mode of development is "retarded," we find even in the adult this Turrilites-like condition of the young, which is as truly reversional as the

Orthoceratitic young of *Goniatites fecundus.* This happens occasionally in the lower Jura, and finally, after the progressive stage of the whole order passes its climax, in the lower and middle Jura, we find the development of a whole group affected by this retardation, and the spiral is common to several generic forms.”

We believe that the author is on a line of investigation bearing most intimately not only on the origin of organic forms, but also on a question next in importance, the law of their extinction. How an animal or plant is produced is a matter of the greatest interest, but is not the cause of its decay and death one almost as interesting?

Since the present essay was published the author has gone to Germany to study the collections of fossil Cephalopods in the museums of Hanover, Stuttgart, Tubingen, etc. From a recent letter we take the liberty of quoting some remarks which confirm the conclusions of his first paper on this subject,* and of the treatise before us.

He took as a test of the whole order the family of Arietidæ, which are confined to one formation, the lower Lias.

“ It is simply wonderful to see how perfectly the geological position of each species in the formations here agrees with its place in the series as determined by development. The successive minor formations of the lower Lias are nothing more than successive faunæ. They are the smallest divisions that it is possible to make in the geological series of rocks, and yet there is no more confusion than results from one species passing by another, or living longer. Thus *a* may live longer than *b* and appear along-side of it, but the young of *b* is like the adult of *a* always. Now, then, I think we can depend upon development to give us the laws of descent, and not only that but more. In fact I feel sure that I can give the reason why one entire fauna is different from the next, or that which preceded it, and why also the species on the same level have some common characteristics. This is the legitimate

Obtusus bed.	*a b*
Angulatus bed.	*a*

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* On the Parallelism between the different Stages of Life in the Individual, and those in the entire group of the Molluscous order Tetrabranchiata (Memoirs of the Boston Society of Natural History Vol. 1. Part 2. 1867). The characteristics of the period of decline of the individual cephalopod shells have been discussed by D'Orbigny. This idea is extended by Hyatt to include the collective life of this order of the class of Cephalopods, during the geological periods in which the order came into existence, culminated, and then declined and went out in forms both reminding us of the embryos of the Nautilus and Ammonite, as well as the earliest generic forms of the order. Thus according to Hyatt's theory the different stages of the life of the individual Nautilus or Ammonites accord with those of the collective life of the entire order.

result of the developmental theory, and must be so, if we can compare the growth of an individual to the progressive existence of a species or a group in time. To do this, however, my old age theory becomes almost as important as development itself, or else the entire period of decline in the different groups and series, and many characteristics of their early beginnings, as well as the resemblances which exist between the forms at the beginnings and at the ends cannot be accounted for. In fact I am now sure that the proportions between the different periods of the life of any one individual may be compared with accuracy to the life of the group to which it belongs; in youth to what the group is in the beginning, in the adult to what it is now, and in old age to what it is to be in the future."

Another point of interest that engaged the author's attention was the discovery of the ancestral form of the Tetrabranchiate Cephalopods. Such a form he is disposed to think occurs in Endoceras. Giving his reasons in full he concludes that "it is in this group, therefore, or in some closely associated genus, that we must look for the ancestors of the Tetrabranchiate Cephalopods." The genus is a subdivision of Orthoceras (belonging to the group Vaginati), a straight-shelled Cephalopod figured in all the text-books. Barrande's opinion is also cited. That distinguished palæontologist has also "settled upon Ascoceras as the prototype, regarding the Vaginati as the nearest allies of Ascoceras."

We may safely say that this is one of the most thorough palæontological essays that have appeared for many a day. The author seems to have had unusual facilities for study, as he acknowledges his indebtedness to the liberal views pervading the management of the museum by which he was allowed to break up valuable specimens in the course of his investigations. The four lithographic plates illustrating the present Bulletin are exquisite.

LIFE HISTORIES OF OUR BUTTERFLIES AND MOTHS.* — These are carefully elaborated accounts of the metamorphoses of some of our common moths (*Sesia diffinis*, *S. Buffaloënsis*, *Thyreus Abbotii*, *Philampelus Achemon*, *Smerinthus geminatus*, *Daremma undulosa*, *Platarctia Parthenos*, *Euprepia Americana*, *Euchætes egle*, *Lagoa crispata*, *Hyperchiria Io*, *Eacles imperialis*, and *Anisota senatoria*) which in some cases were raised from the egg. We find many

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* Entomological Contributions, No. II. By J. A. Lintner. From the twenty-fourth Annual Report on the New York State Museum of Natural History, for the year 1870. 8vo. pp. 66.